168224

NHTSA-2002-11419-13

HONDA

American Honda Motor Co., Inc.
1919 Torrance Boulevard
Torrance, CA 90501-2746
Phone (310) 783-2000

May 7, 2002

Docket Management Room PL-401
National Highway Traffic Safety
Administration
400 Seventh St., SW
Washington, DC 20590

Re: Docket No. 2002-11419

Dear Sir:

Please find enclosed two copies of the comments of American Honda Motor Co. with regard to the above captioned matter. Some of the materials submitted are confidential, and will be submitted through the Office of Chief Counsel. Additional materials will also be submitted concerning the tables when complete information has been obtained. Therefore, we will be supplementing this submission.

Thank you.

Very truly yours,

AMERICAN HONDA MOTOR CO., INC.

William R. Willen
Managing Counsel
Product Regulatory Office

WRW:rpb

168224

NHTSA-02-11419

**Honda Response to
NHTSA Request for Comments on CAFE
67 FR 5767, February 7, 2002**

Comment Deadline: May 8, 2002

Honda appreciates the opportunity to comment on the National Academy of Science Study and Future Fuel Economy Improvements for Model Years 2005-2010. Since its beginning in 1948, Honda has been guided by its philosophy of providing clean and efficient products of the highest quality at a reasonable price to its customers worldwide. For example, the 2000 Honda Insight, which achieves an EPA rating of 61 mpg (city) and 68 mpg (highway), was the first gasoline-electric hybrid vehicle introduced in the United States. And in March, 2002 we introduced the all new Civic Hybrid – the first regular production vehicle that will be available with three different powertrains – conventional gasoline, compressed natural gas and hybrid engines.

In this same light, Honda's fleet has always been one of the most efficient in the nation. Our combined car and light truck CAFE average for 2001 was 30.2 mpg. Our light truck fleet was 25.0 mpg. While fuel efficiency is a high priority for us, we know from our long experience with this issue that we must produce vehicles that our customers will want to buy. The challenge for all of us is finding the critical balance between overall societal needs (reduction of greenhouse gas emissions and reduced reliance on petroleum) with the individual needs and demands of our customers. We believe it is time for a constructive discussion about motor vehicle fuel efficiency. The goal must be to develop requirements that are fair and equitable for all manufacturers and that improve energy efficiency and resource conservation.

Overview of Honda's Positions

Honda does not oppose CAFE increases and we so testified before the Senate Commerce Committee on three different occasions. In our testimony, we said:

- Any CAFE legislation should (1) be technologically feasible; (2) provide sufficient leadtime for manufacturers to re-engineer their vehicles; and (3) require that all manufacturers meet the same standards at the same time.
- The analyses in the NAS report on the cost, fuel economy improvement, tradeoffs with other attributes desired by customers, and leadtime for improving new vehicle fuel efficiency are "in the ballpark". As explained in our response to Question 2, below, Honda does not support the individual technology estimates, but we believe that, in aggregate, the technology analyses in the NAS Report are reasonable.
- The only significant conclusion of the NAS report with which we took exception was the majority findings on the safety effects of weight reduction. Honda, instead, supported the minority position that existing safety analyses available to the NAS committee were based on older vehicles with outdated safety technology and that further research is needed in order to quantify the impact of weight reduction on overall deaths and injuries.
- In support of the last point, Honda has underwritten new research by DRI that demonstrated that a 100-pound reduction across the board in all vehicle classes would not have a statistically significant impact on fatality rates.
- We urged that NHTSA be assigned the task of developing the details of the standards.

By "technologically feasible", we don't mean simply that the technology exists. "Feasible" includes the cost to the customer, including tradeoffs with other features valued by the customer, such as performance, utility, and comfort. Any study of technological feasibility must include an assessment of these tradeoffs.

As long as the above criteria are met, Honda will continue to not oppose CAFE increases.

CAFE Standards

There is a popular misconception that vehicle manufacturers have not introduced fuel-efficient technologies since the mid 1980s. This is understandable, as the car and light truck CAFE have remained relatively constant for the last 15 years. However, the reason for this flat line is not a lack of technological progress. The combined fleet has gone down due to increasing light truck market penetration – and due to the increasing array of features demanded by customers. There has been a substantial amount of efficiency technology introduced by the industry in that time period. For example, EPA reported in its 2000 Fuel Economy Trends Report that penetration of lock-up torque converters increased from just under 30% in 1980 to 100% in 2000. Similarly, the use of port fuel injection increased from 5% in 1980 to 100% in 2000. From its introduction in 1985, penetration of 4 valves per cylinder reached 40% in 2000. The dilemma facing manufacturers is that consumers may not value using these technologies to improve fuel economy, given the relatively low price of gasoline.

These new technologies have been employed more to respond to vehicle attributes demanded by the marketplace than to increase fuel economy. Over the past two decades, consumers have insisted on such features as enhanced performance, luxury, utility, and safety without decreasing fuel economy. Although vehicle weight increased 12% from 1987 to 2000, the 0-60 time improved by 22% in the same time period. This is because average horsepower increased by 70% from 1982 (99 hp) to 2000 (170hp). In addition, the proportion of manual transmissions, which are more fuel-efficient than automatic transmissions, decreased from 32% in 1980 to 14% in 2000. It is clear that technology has been used for vehicle attributes which consumers have demanded and value more than fuel economy.

Based upon data in EPA's Fuel Economy Trends Report, if the current car fleet were still at 1981 performance, weight and transmission levels, the passenger car CAFE would be almost 36 mpg instead of the current level of 28.1 mpg[1]. The trend is particularly pronounced since 1987. Technology has gone into the fleet from 1987 to 2000 at a rate that could have increased fuel economy by about 1.5% per year, if it had not instead focused on other vehicle attributes demanded by the market. There is no reason why this technology trend of improved efficiency (as opposed to fuel economy) should not continue.

[1] This calculation is based on data from EPA's "Light-Duty Automotive Technology and Fuel Economy Trends" report, September 2001. Figure 45 on page 51 directly shows the impact of changes in car weight and acceleration. An estimate of the shift away from manual transmissions, based upon EPA's data, was also added, although this is a relatively minor effect.

This pace of potential improvement is significant in the context of the NAS finding that "[t]technology changes require very long lead times to be introduced into the manufacturers' product lines." Accelerated mandates that are met through piecemeal modifications to existing vehicle designs, rather than through integration of fuel-efficient technologies from the inception of a new vehicle design, can have disruptive and undesirable effects. The NAS notes that the downweighting and downsizing that occurred in the late1970s and early 1980s may have had negative safety ramifications. As we discuss later in our response to question 1, this demonstrates the critical nature of lead-time. Negative safety concerns can occur if standards are raised too much, too fast, as was the case in the late 1970s and early 1980s. However, if sufficient lead time is allowed, the ability to "design in" fuel economy from the beginning – through the use of aerodynamic styling, enhanced use of lightweight materials, and incorporation of the newest drivetrain technologies - can produce significant fuel savings with little sacrifice of other vehicle attributes that consumers desire.

We believe that any future fuel economy requirements should be stated in terms of performance and should be technology neutral. Standards should be set with due consideration of the challenges faced by manufacturers to offer consumers the mix of vehicles and vehicle attributes they desire.

The NAS Study is based upon the assumption that the current model mix will not change. However, the market has been continuously demanding more utility and performance and there is no reason to assume that this will not continue. Unless the customer becomes an integral participant in the process of reducing greenhouse gases, market acceptance of fuel efficient products will be limited. Programs will be far more effective if they include government and customers, not just industry. The industry can provide a "pull" by providing products desired by the consumer. But, we cannot push customers into buying vehicles they do not want. Government programs to stimulate demand, provide incentives, and educate the customer could dramatically affect acceptance of new technologies and market penetration.

<u>NAS Study</u>

The recent report of the National Academy of Sciences (NAS) entitled "Effectiveness and Impact of Corporate Average Fuel Economy Standards" provides the Committee with a good point of departure for considering this complex technological, economic and public policy issue. We commend the NAS on its report on fuel economy. While we do not agree with all the findings and recommendations, the Panel had a formidable task, which it completed on an extremely tight time frame.

As we will discuss, a number of the recommendations of the NAS on any future increase in CAFE parallel our thinking. The report recognizes the importance of providing adequate lead-time to design and introduce new technology to meet future standards. The report focuses on a 15-year timeframe. Certainly, the more significant the increase in the standard, the longer the lead-time needed. The report also discusses alternatives to the current CAFE program. We concur in the Panel's observation that some of these alternatives have the potential to reduce the nation's fuel consumption without the market distortions created by the CAFE system. We also note the report is not unanimous on its position with regard to safety. We have more to say about this critical issue later, but we concur that more research is warranted.

As discussed earlier, we concur with the NAS finding that "[t]technology changes require very long lead times to be introduced into the manufacturers' product lines."

As long as adequate leadtime is provided, the technology analyses in the NAS report are reasonable. Similar to Honda's position, the NAS found that there are significant amounts of conventional technology that can be applied to the vehicle fleet, but that, absent incentives, hybrids currently cost too much for mass market acceptance and fuel cells are not ready for the consumer market. The minor corrections in the NAS Letter Report of January 16, 2002 and the committee's stated desire for readers to focus on the average results, instead of the upper and lower bounds, are also reasonable. The fuel efficiency and cost estimates in the NAS report are in the ballpark and can be used to help Congress balance the nation's need to conserve energy with consumer acceptance of the costs and impacts on other consumer attributes.

Honda's support for the numbers in the NAS report is not for the individual fuel economy estimates. The NAS committee also studied the economic cost of the different technologies, including tradeoffs with other features desired by customers, such as performance, utility, and luxury. Honda supports the overall, composite results prepared by the NAS committee, such as their "cost effective" analyses and leadtime analyses, not the individual estimates in isolation. We also support the analytical framework developed by the NAS Committee to estimate CAFE levels based upon different assumptions of the value of fuel savings and externalities, such as energy security and global warming.

Safety Issues

It is significant that safety considerations are the only issue that produced a dissenting opinion in the NAS Report. Honda concurs with that dissenting opinion expressed by committee members David Greene and Maryann Keller, that the data is insufficient to conclude that safety is necessarily compromised by smaller vehicles. The level of uncertainty about fuel economy related safety issues is much higher than stated in the majority report.

As the dissenters state, "[t]he relationship between vehicle weight and safety are complex and not measurable with any degree of certainty at present." We believe it is important to understand the differences between size and weight. We have demonstrated through the use of sophisticated engineering and advanced lightweight materials that smaller cars can be made increasingly safer. For example, Honda's 2001 Civic Coupe, with a curb weight of 2502 pounds, was the first compact car to receive a five star safety rating in the NHTSA crash results for both the driver and passengers in frontal and side crashes. The fuel economy of the Civic HX coupe with a continuously variable automatic transmission (CVT) and a gasoline engine is 40 mpg (highway) and 35 mpg (city). In addition, there are many ways to increase fuel efficiency that do not affect weight, such as improved engine and transmission technology and more efficient use of space.

Thus, vehicle design and size, and not just vehicle mass, must be considered when studying the relationship between fuel economy and safety. There are some accident scenarios where less weight may actually be an advantage. For example, lighter vehicles pose less danger to other vehicles they may collide with. In other accident scenarios, lighter weight is a disadvantage. But, there is much we do not know. For example, to what extent can advanced crash avoidance technologies, such as forward collision warning/avoidance, lane keeping and road departure prevention, and lane change collision warning/avoidance systems, be employed to make weight considerations less relevant? To what extent can new, lightweight materials and sophisticated engineering provide a level of crash protection comparable or even superior to vehicles with traditional materials and designs?

Honda supports the NAS recommendation that NHTSA undertake additional research to clarify the relationship of weight and size in the context of newly evolving advanced materials and engineering techniques in the array of accident scenarios that are encountered on American roads. Honda recently retained a contractor, Dynamic Research, Inc. (DRI), to update NHTSA's 1997 analysis of the safety effects of reducing weight by using more recent accident data with newer vehicles. The conclusion is that the effect on traffic fatalities of a 100-pound weight reduction on the combined car and light truck fleet is very small and not statistically significant. On January 15, 2002, DRI presented an extensive overview of the analysis to NHTSA staff. NHTSA indicated that DRI appeared to have done a credible job of replicating their statistical techniques and updating their earlier analysis. The updated analysis indicates that weight reduction across the entire vehicle fleet may not have a negative safety effect.

NHTSA Requests For Supporting Data:

Following are responses to each of the Specific Questions/Areas of Comment from the FR Notice. Note that the numbering tracks the FR notice. Detailed support data are contained in appendices and referenced in the following discussion.

1. *NHTSA requests comments on the NAS report finding that the current CAFE program has contributed to traffic fatalities and injuries. Is the safety impact understated or overstated? Would NAS's proposed changes to the CAFE program reduce this safety penalty? Could CAFE standards be modified so that manufacturers are encouraged to achieve improved fuel economy through application of technology instead of through downsizing and downweighting? NHTSA requests comments on the extent to which increase in LT CAFE are feasible during 2005-2010 MYs and whether any of these increases would involve means (e.g., significant weight or size reduction) that could adversely affect safety. If there would be adverse effects, how could they be mitigated?*

As discussed above, Honda believes that the majority finding in the NAS Report on safety only applies to older vehicles. It is important to recognize that the CAFE standards adopted by Congress in 1975 imposed very stringent standards with very short leadtime. The lack of adequate leadtime resulted in vehicle downsizing and weight reduction without proper consideration of safety impacts. Thus, the CAFE standards imposed in the early 1980s, without adequate leadtime, likely had a significant safety impact. As the 1997 Kahane Study only considered vehicles older than 1993, it properly reflected that CAFE standards had led to increased fatalities and injuries on older vehicles. However, over time, manufacturers have continuously improved the safety of their vehicles while continuing to meet the CAFE standards.

This is not reflected in the older safety studies considered by the NAS committee. As illustrated by the recent DRI report, reasonable weight reduction on vehicles with modern safety equipment is less likely to have a safety impact.

There are two clear lessons here:

- Newer vehicles have very different safety characteristics than older vehicles. Safety studies using older model year vehicles cannot be used to predict the behavior of vehicles with improved safety designs. This is why Honda supports the NAS Recommendation for further safety research.
- Adequate leadtime is essential for a number of reasons, including safety.

Of course, it is possible to enhance vehicle safety by narrowing the discrepancy between the size and weight of the smallest and largest vehicles. Any CAFE structure that imposes larger tasks on larger vehicles will tend to have this effect, as it creates larger incentives for the largest vehicles to reduce weight. It should be noted that just raising light truck CAFE standards under the existing structure would tend to have this effect, for two reasons:

- Reducing weight on larger vehicles generates a larger CAFE benefit than reducing weight on smaller vehicles.
- Reducing weight only on light trucks would tend to narrow the discrepancy between light trucks and cars

The key to enhancing fuel economy without degrading safety is leadtime. The first option employed by manufacturers to meet any increase in CAFE standards is likely to be improved vehicle technology. As size is strongly related to vehicle comfort and utility, the next option (if needed or desired) would be to use lighter weight materials, not reduce vehicle size. Most studies assume that size and weight are reduced proportionally. While there are no available data to quantify the effect of reducing weight without reducing size, theoretically it should reduce any potential safety impacts. This is because crush space is maintained in collisions and wheelbase and track are maintained to avoid increased rollovers. Only if the CAFE standards are extreme and on a very short timeframe will manufacturers be forced to reduce the size of their vehicles. Honda believes that safety should not be a major consideration in this rulemaking as long as the factors described above are adequately reflected in whatever standards the agency promulgates. However, more study by NHTSA is needed to quantify and confirm this conclusion.
Leadtime also affects the feasible increase in fuel economy. As the NAS Report states, "Technology changes require very long lead times to be introduced into the manufacturers' product lines and the widespread penetration of even existing technologies will probably require 4 to 8 years. For emerging technologies that require additional research and development, this time lag can be considerably longer." The implicit leadtime in the NAS Report is about 12-14 years, considerably longer than the 2005-2010 period in the Request for Comments. NHTSA needs to include this factor in their analyses.

2. *What is the technological feasibility and economic practicality of various fuel efficiency enhancing technologies that fall under the general headings of engine, transmission, and vehicle technologies? Please comment on each of the following:*

Engine Technologies - engine friction and other mechanical/hydrodynamic loss reduction; advanced low-friction lubricants; multi-valve, overhead camshaft valve trains; variable valve timing; variable valve lift and timing; intake valve throttling; cylinder deactivation; engine accessory improvement; engine downsizing and supercharging; camless valve activation; variable compression ratio engines; electronic engine controls; direct fuel injection for SI or diesel engines; lean burn-fast burn combustion; and two-stroke engines.

Transmission Technologies - 5-speed auto transmission; 6-speed auto transmission; continuously variable transmission; advanced continuously variable transmission; auto shift manual transmission; and auto transmission with aggressive shift logic.

Vehicle Technologies - aerodynamic drag reduction; electronic controls; lowering rolling resistance; vehicle weight reduction; substitution of lighter-weight materials; 42-volt electrical system; integrated starter/generator; hybrid drive trains; and fuel cells.

For each of these and other technologies, the notice requests specifics on:

a. impact on fuel efficiency
b. costs and benefits to the consumer
c. manufacturer costs
d. lead time
e. degree of current use in cars in LTs
f. impacts on safety, including injuries and fatalities
g. potential fleet penetration
h. effects of environmental (especially emissions standards) and other regulations on application/penetration. [Note: With respect to penetration, commenters are requested to distinguish between technologies that may be appropriate for LTs that would not need high load carrying or towing capability.]

There is a fundamental problem with estimating the impact of an individual technology on fuel efficiency – it is dependent on what other technologies are already on the vehicle and on the characteristics of the vehicle. Different technologies frequently have benefits on the same kind of efficiency loss, such as engine friction or pumping losses. Thus, a technology may be less effective if another technology that offers similar benefits is already being used. This is illustrated in Appendix F, Attachment E of the NAS Report, which lists the fuel economy benefits of various technologies relative to both a baseline case and a reference case. These numbers are usually very different. For example, cylinder deactivation is estimated to improve fuel consumption by 8-16% on a basic 2-valve/cylinder engine, but only 3-6% if the engine already has OHC, 4 valve/cylinder, variable valve timing, and variable valve lift. The order in which technologies are considered has a profound effect on the fuel efficiency benefit of each individual technology.

This means that there is a range of reasonable assumptions that can be made. This point was made very clearly by Professor David Foster of the University of Wisconsin at a March 6, 2002 SAE Panel assessing the technologies estimates in the NAS Report. Professor Foster stated there are "Differences of opinion as to what are reasonable assumptions when projecting fuel consumption reduction potential for the next 15 years." He explained that there are many challenges in describing the vehicle and that detailed data are necessary. Thus, "Engineering judgements are needed in making these projections and each group integrates a different set of experiences into the judgements they use." Professor Foster's conclusions included:

- "There is no single, simple answer to the question – engineering judgement is involved."
- "In the time frame allowed and resources available, the NRC committee used its best engineering judgment to project future reductions in fuel consumption."

Honda's support for the technology estimates in the NAS Report needs to be viewed in this context. Honda does NOT support each individual fuel consumption benefit and cost estimate in the NAS Report. Indeed, our own estimates differ in many cases, as our baseline technologies are different. However, the NAS assessments have been exhaustively reviewed and commented on and, overall, their assessments of technology packages are in the ballpark. Thus, they are the best publicly available source of information.

With this background, Table 1 provides Honda's estimates for the fuel economy benefits of the various fuel economy technologies. This table also shows the use of these technologies in Honda's vehicles.

Table 1 - Fuel Economy Techology Usage and Estimated Benefits

	FE inc. est.	CR-V 01	CR-V 02	CR-V 05	Model-X 03	Odyssey 01	Odyssey 02	Odyssey 05	MD-X 01	MD-X 03	Pilot 03	Pilot 05	Applied in 2005
ENGINE TECHNOLOGY													
Engine Friction Reduction													
Low Friction Lubrication (inc. 5W-20)													
4-valve/cylinder OHC (vs 2-valve/cyl)													
Roller Cam Followers													
Low Friction Piston Rings													
Lean-burn													
VVT (cam-phasing)													
VVLT (2-step)													
Intake valve throttling (vs VVLT)													
Camless valve actuation (vs VVLT)													
Cylinder deactivation													
Variable Compression Ratio (vs VVT)													
Engine accessory improvement													
Supercharging and engine downsizing													
TRANSMISSION TECHNOLOGY													
Percent automatic transmission													
Torque Converter Lock-Up													
5-speed automatic													
automatic w/ aggressive shift logic													
6-speed automatic (vs 5-speed)													
automatic shift manual transmission													
CVT													
high torque CVT													
VEHICLE TECHNOLOGY													
aerodynamic drag (per 10% reduction)													
tire rolling resistance													
42V electrical system													
ISG with idle off													
Hybrid electric													
Electric power steering													
Weight reduction													
Aluminum block engine (wgt reduction)													

However, fuel economy technology cannot be assessed in isolation. As discussed earlier, there are other attributes more highly valued by customers, such as performance, utility, and comfort. Thus, much of the technology going into our future vehicles will be offset by these features. Table 2 summarizes the performance, utility, and weight of our light trucks.

Table 2 - Attributes of Honda's Light Duty Trucks

	CR-V			Element	Odyssey			Acura MD-X		Pilot	
Attributes/Model	2001	2002	2005	2003	2001	2002	2005	2001	2003	2003	2005
ETW(lbs)[1] Range[2]											
Length											
Width											
Height											
Passenger vol											
Cargo vol											
Towing capacity											
Engine size (L)											
Horsepower@rpm											
Torque (ft-lb)@rpm											
Compression ratio											
FE (city/hwy)[3]											

[1] AT 2WD

[2] (YYYY-ZZZZ) means a range when considering all type (4WD, MT etc)

[3] FE label values (adjusted 10% city/22% highway from CAFÉ test results)

3. *What is the cost-effectiveness of each technology identified in Q2 and any other relevant technologies, assuming alternative plausible gasoline prices forecast for MY 2005-2010, and assuming alternative payback periods ranging from 3 to 10 years?*

The cost of each technology can also be affected by the order in which it is added. For example, varying the timing of the intake camshaft relative to the exhaust camshaft (the NAS report refers to this as "variable valve timing", or VVT) requires dual overhead camshafts (DOHC), but can sometimes be used to replace EGR systems. Thus, the cost is dependent upon whether or not DOHC is already on the vehicle and whether or not there is an EGR system that can be eliminated. Thus, for engines with DOHC and EGR systems, there might be a cost savings by going to VVT. For an engine without OHC and without an EGR system, the cost of going to VVT is substantial.

Given the uncertainty in the estimates of both fuel consumption benefit and cost of individual technologies, cost-effectiveness estimates of individual technologies are highly uncertain. Estimating the cost-effectiveness of technology packages, as was done by NAS, is more robust. Honda's estimates of the cost and the cost-effectiveness of technology packages are shown in Table 3.

INSERT COST TABLE HERE

4. *Taking into account the response to Q2 and recent statements of GM, Ford, and DCX that they will improve LT fuel economy by 2005, indicate the ability of each manufacturer to improve its LT CAFE for each MY 2005-2010. Specify improvements on a vehicle-by-vehicle basis that will result in the achievement of the manufacturer's pledge. For each vehicle, list specific technologies that will be employed and the increase in fuel economy attributed to each technology. By what MY would maximum penetration of all current fuel economy enhancing technologies be feasible? Why wouldn't such maximum penetration be feasible earlier?*

Honda does not have any data on which to comment on the ability of other manufacturers to improve their LT CAFE. Similarly, we have no ability to comment on the improvements that will result in the achievement of the manufacturers' pledges.

In general, it takes at least 10 years from the point of initial introduction to roll a technology out throughout a manufacturer's fleet, assuming that the technology is cost-effective and desired by customers. This is due to the R&D needed to adapt the technology to each different product, time needed to tool and source parts for increased production, and product redesign cycles of about 5 years. This is supported by analyses of market penetration of new technologies in the 2001 EPA Fuel Economy Trends Report (see Figure 40).

Forcing earlier penetration would cut into quality assurance, force accelerated tooling, and force introduction before the natural product redesign cycle. All of these dramatically increase costs and increase risk of customer rejection. These effects are discussed at length in the NAS Report.

Honda completely supports the findings in the NAS Report on the need for adequate leadtime when setting CAFE standards.

5. *What analyses of manufacturer LT fuel economy capabilities for MY 2005-2010 are available? What are the strengths and weaknesses of each such analysis?*

There are three primary public analyses of manufacturer LT fuel economy capabilities:

- EEA (Energy and Environmental Analyses, Inc). "Technology and Cost of Future Fuel economy Improvements for Light-Duty Vehicles." 2001. Available in the National Academies public access file for the NAS Committee Report.
- Sierra Research. "A Comparison of Cost and Fuel Economy Projections Made by EEA and Sierra Research." 2001. Available in the National Academies public access file for the NAS Committee Report.
- ACEEE, John DeCicco, Feng An, and Marc Ross, for the Energy Foundation. "Technical Options for Improving the Fuel economy of U.S. Cars and Light Trucks by 2010-2015". April, 2001.

All of these groups have issued a series of technology papers and reports over the last decade or so – the above are just the most recent versions. Related analyses have also been done by David Greene of ORNL (Oak Ridge National Laboratory), the Union of Concerned Scientists, Steve Plotkin of Argonne National Laboratory, and the Department of Energy.

All of these analyses are technically accurate – they simply differ in the engineering and economic assumptions made. Unfortunately, as discussed by Dr. Foster, there are a wide range of reasonable assumptions that can be made, with significant impacts on the results. Analyzing and combining individual technologies is especially problematic, as discussed earlier. What is really needed is a complete, complex computer model of all possible factors, which can properly account for all synergies. Such a model does not exist, at least one that is publicly available.

The NAS Committee reviewed all of the available analyses in detail. Honda believes that the NAS Report did a credible job of balancing assumptions and can be used as a reasonable basis for setting CAFE standards.

6. *What data are available on the usage characteristics of LTs, i.e., how many passengers and how much cargo the different types of LTs typically carry? What survey and other data are available on the importance that consumers place on the fuel economy of LTs relative to other vehicle attributes?*

Honda is not aware of any publicly available data on how many passengers and how much cargo personal-use light trucks carry. DOT published a report on February 1996 on "Light Truck Capabilities, Utility Requirements and Uses: Implications for Fuel Economy. In Section 3.5.6 on page 3-21, the report stated, "Reliable data could not be found on the extent and type of cargo-carrying usage for personal-use light trucks." For commercial light trucks, there is data from the Truck Inventory and Use Survey, usually conducted every 5 years by the Census Bureau (US Department of Commerce).

Honda has conducted some internal surveys, but these surveys were conducted specifically to help Honda develop a durability mode for emission compliance. Thus, only the number of passengers, towing condition, and loading condition data are available. The importance of fuel economy to light truck purchasers is not available through this survey.

Honda surveyed owners of 60 pickup trucks, 60 SUVs, and 30 minivans in each of California and Michigan. Most of the owners surveyed drove vehicles built by other manufacturers. The owners were given a questionnaire about their vehicle usage – the data is the owner's recollection of their vehicle usage.

Number of passengers

	Business	Leisure	Other	Average
Pickup truck	[ ]	[ ]	[ ]	[ ]
SUV	[ ]	[ ]	[ ]	[ ]
Minivan	[ ]	[ ]	[ ]	[ ]

Towing

	% of owners who tow		
	Business	Leisure	Avg tow weight
Pickup truck	[ ]	[ ]	[ ]
SUV	[ ]	[ ]	[ ]
Minivan	[ ]	[ ]	[ ]

Note that the survey did not address how often owners towed.

Load weight

	Business	Leisure	Other	Average
Pickup truck	[ ]	[ ]	[ ]	[ ]
SUV	[ ]	[ ]	[ ]	[ ]
Minivan	[ ]	[ ]	[ ]	[ ]

7. *By their nature, fuel economy standards lower the marginal cost of driving. What effect does this cost difference have on vehicle miles traveled?*

The impact of the marginal cost of driving on VMT (vehicle miles traveled) has been extensively analyzed. Unfortunately, there is no consensus. A major analytical problem is that the only significant, long-term fuel price increase occurred during the 1970s. This period of fuel price increase coincided with the onset of CAFE standards, gasoline shortages, and fears of ever increasing fuel prices. This correlation between causal factors makes it virtually impossible to separate out the impact of the marginal cost of driving. It is clear that assigning all of the impact to fuel price is incorrect, as public fears of fuel shortages and continuing price increases were also major factors. However, there are a wide range of reasonable assumptions that can be made short of this.

Having said this, it is likely that the marginal impact on VMT of raising the fuel economy standards will be low. The marginal cost of driving a mile is already about half that of the early

1970s, before the first oil crisis - the real, inflation adjusted price of fuel is less than it was in the 1970s and average vehicle fuel economy is much higher. In addition, there has been a large increase in real household disposable income, which makes the marginal cost of driving less important to most households. Factors other than the marginal cost of driving are already substantial limitations on VMT, such as congestion and time lost behind the wheel. A further reduction in the marginal cost of driving a mile is not likely to have a large impact on VMT.

8. *To what extent are other Federal standards likely to affect manufacturers' CAFE capabilities in MY 2005-2010? Comments should include not only the effects of such standards when first implemented, but also the prospect for reducing those effects subsequently.*

With respect to Federal safety standards, it can be expected that future Federal Motor Vehicle Safety Standards will continue to require structural improvements and additional safety devices in future models. Many of the FMVSSs expected to take effect in the 2005-2010 timeframe are proposed but not yet finalized by NHTSA. Additionally, as the FMVSSs are "performance" rather than "design" standards, it is not possible to accurately predict how much added weight will be required to meet the new safety requirements. As with fuel economy technologies, if adequate lead-time is provided to phase-in the new safety items in an orderly basis, such as in development of a new model, the effects can be less than if they must be incorporated into an existing model.

With respect to Federal emission standards, with one exception, emission standards should not significantly impact new vehicle fuel economy. Upcoming emission standards will be met primarily with improved air/fuel control, faster catalyst light-off, and improved catalysts. While there may be significant costs involved with meeting the requirements, these changes should not significantly impact fuel economy.

The exception is lean-burn. For gasoline engines, NOx emissions are controlled primarily with catalytic reduction. Modern air/fuel control and catalyst formulations can allow over 99% NOx reduction efficiency after the catalyst is hot. However, the reduction process involves splitting NOx into nitrogen and oxygen. This reaction is prevented if there is already free oxygen in the exhaust. Thus, conventional catalytic NOx reduction does not work with a lean air/fuel mixture.

Many people believe that NOx emissions are higher during lean-burn. This is not accurate. There is a slight increase in NOx emissions as air/fuel ratio is enleaned from stoichiometry (about 14.6:1) to about 16:1, but engine-out NOx emissions drop rapidly with air/fuel ratios leaner than 16:1. However, this engine-out reduction is not enough to offset the loss of catalytic NOx reduction, which is extremely high. Some kind of aftertreatment is needed.

The most promising solution for gasoline engines is lean-NOx storage catalysts, or NOx traps. Materials can be added to the catalyst that absorb and store NOx during lean operation. The air/fuel system is shifted back to stoichiometric or slightly rich operation every 40-50 seconds to reduce the stored NOx and reactivate the sites for further NOx storage. This reduction process usually takes less than a second.

CONFIDENTIAL

Stored NOx can be reduced at relatively low temperatures. Unfortunately, sulfur in the fuel interferes with this process. SOx is an acid gas like NOx and, like NOx, it is absorbed in the catalyst during lean operating conditions. However, SOx is not reduced as easily as NOx. It takes high temperatures and much longer periods of enrichment to remove SOx. Thus, sulfur quickly locks up the absorption sites and the adsorption of NOx is blocked. With the typical sulfur levels in Federal fuel, about 300 ppm, the process of blocking most of the NOx absorption sites takes only a few hours.

The sulfur reductions promulgated by EPA as part of the Tier 2 process will reduce sulfur in most of the nation to an average of about 30-ppm in 2006. This will help a great deal, but may not be enough due to accumulation of sulfur on the catalyst. The following chart shows the accumulation of sulfur from gasoline on a lean-NOx storage catalyst at 350°C and lean air/fuel conditions. When sulfur concentration is high, its impact on the deterioration of the Lean NOx Catalyst is very large. However, even 30-ppm sulfur fuel has major impacts on the catalyst conversion efficiency.

As a concrete example, Honda was the first company to use a lean-NOx storage catalyst in the US, on our Honda Insight. Without any sulfur in the fuel, this catalyst has a lean-NOx reduction efficiency of about [ ]. Combined with lower engine-out NOx emissions during lean operation, this would allow compliance with the Tier 2 standards. However, with typical Federal sulfur levels of about 300 ppm, the reduction efficiency is only about [ ] - the amount of NOx passing through the catalyst increases from [ ], or about a times [ ] increase. Even with 30-ppm sulfur fuel, the NOx reduction efficiency drops to about [ ], or about a times [ ] increase. This efficiency level is not high enough to be able to pass the Tier 2 standards.

We are working on catalyst formulations that will resist sulfur better and make it easier to remove after adsorption, but we do not know if we can achieve lean-NOx storage efficiencies high enough to meet the Tier 2 standards. Thus, the Tier 2 emission and fuel composition standards may preclude lean-burn engine technologies.

Diesels have the same problem, as they are inherently lean burn. However, as Honda does not sell diesels in the US, we cannot comment on the potential for diesels to meet the Tier 2 standard.

9. *In setting CAFE standards, the agency considers that there are often technological risks associated with actually achieving the full potential fuel economy improvement from a particular technology. How should the agency take technological risks into account in setting LT CAFE standards? What technological risks are associated with gaining the full potential fuel economy improvements from available technologies? What are the prospects for overcoming these risks or offsetting their effects?*

The best way to overcome these risks is to allow adequate leadtime. With sufficient leadtime, a manufacturer can properly assess the fuel economy potential of technology bundles and make adjustments if necessary. The NAS Report considered these risks when it established its fuel efficiency estimates. If the estimates are used appropriately and with sufficient leadtime, there should not be any significant risk with gaining the full potential fuel economy improvements from available technologies.

10. *Taking note of the NAS report, please comment on the idea of attribute-based standards, including which attributes such a system should be based on and the specific vehicle classes that might fall under such a system. Also, please suggest the fuel economy level to be associated with each class of such a system.*

Adjusting standards for vehicle attributes, such as size, class, or weight, changes the focus to vehicle efficiency, rather than economy. The fuel economy task is similar for every market segment, which minimizes the influence on customer choice, competitive impacts, and any perceived concerns about impacts on vehicle safety. In addition, such a structure automatically adjusts for unexpected market shifts. The downside of attribute-based systems is that overall fuel consumption reductions are uncertain, as they depend on future market shifts and they remove all constraints on continued market shifts towards larger vehicles. In addition, the systems are complex - it is difficult to establish proper criteria, classify vehicles, and assign future appropriate standards.

Honda neither supports nor opposes attribute-based systems, in general. There are advantages and disadvantages to both the existing CAFE structure and attribute-based systems. However, if an attribute-based system is adopted, it is important that it be constructed properly.

The first choice is between a weight-based system and one based on size or vehicle class. At first glance, weight-based systems are attractive. They are easier to structure and a reasonable correlation can be found between fuel economy and weight of current vehicles. The NAS Report included an example of such a system, which they called an "Enhanced CAFE" system.

Unfortunately, weight-based systems have two significant problems. The primary problem is that manufacturers would get no credit for substitution of lightweight materials or better packaging efficiency. Indeed, manufacturers might be punished by being forced to meet a higher standard. There is currently a great deal of research on alternative materials and lightweight body structures. While no manufacturer will introduce these if there is a significant negative impact on safety, there is promise that lightweight materials and/or more efficient packaging can be implemented without any impact on safety. However, there simply would be no reward for such changes under a weight-based approach. In fact, if the system is not properly structured, there may even be an incentive for *increasing* weight. Significantly, this disincentive would not exist for a system based on size or vehicle class.

The second problem with a weight-based system is setting future standards. It is all well and good to establish a correlation between weight and fuel economy for current vehicles, but this correlation is not predictive. Determining the proper weight curve for future standards is uncharted territory – note that the NAS Enhance CAFE approach only included a baseline weight curve. Establishing a weight curve for future CAFE compliance would be very difficult and may lead to unexpected results.

In theory, size or class adjustments work better than weight adjustments. Properly constructed, size/class adjustments achieve the benefits of a weight-based system while still preserving incentives for fuel economy improvements through the use of lightweight materials and improved vehicle packaging. However, the difficulties in establishing appropriate size or class criteria are obvious, especially for light trucks (unlike weight-based systems, which appear relatively easy on the surface and whose difficulties are not obvious at first). The use of measured interior volume works reasonably well for most cars, but this approach has never been applied to light trucks.

If a size- or class-based approach is desired, there is an obvious starting point. The NAS Report has already analyzed future cost-effective standards for six different classes of light trucks – minivans, small SUVs, midsize SUVs, large SUVs, small pickups, and large pickups. It would also be relatively easy to extend their analysis to large vans and midsize pickups. These light truck analyses could readily be used to set future standards for each of these light truck classes. The spreadsheet developed by the NAS committee can easily adjust standard levels to incorporate different assumptions about the value customers place on fuel savings, leadtime, and the value of externalities, such as the need of the nation to conserve energy and CO2 reduction. This system could also be structured to include other concerns, such as treatment of commercial vehicles, credit trading, and interpolation between classes, if desired.

While this system could relatively easily assess different CAFE levels for different classes, defining which future vehicle should fall into each class is more difficult. The classes used for the NAS Report are taken from the EPA FE Trends Report. This report divides light trucks into van, pickup, and SUV classes, then divides each of these into three size classes based upon wheelbase. This works reasonably well for the current fleet. However, wheelbase is not the best metric for future vehicles, as it is possible to design relatively small vehicles with relatively large wheelbase. Thus, it would be highly desirable to develop a more robust measure of vehicle size that is less susceptible to gaming.

Interior volume may work well for vans and SUVs. While this has not been used in the past, the SAE procedures developed for measuring the interior volume of station wagons work satisfactorily on vans and SUVs. The only modification that might be needed would be to put a limit on the amount of useable headroom in the calculation (to prevent just raising the roof beyond what is needed for passenger seating). It should be possible to develop interior volume cutpoints that correlate well with EPA's wheelbase criteria for current vehicles.

Clearly, interior volume will not work for pickups. Overall size metrics would be better than wheelbase, such as overall length, overall width, or length x width. Note that such a metric could also be used with vans and SUVs, if desired. Another possibility might be the pickup bed width between the wheels, or bed length x width. (Note that some sort of minimum bed size requirement would likely be needed anyway in order to separate future crossover vehicles into the appropriate pickup versus SUV category.) Hopefully, criteria could be developed that correlate reasonably well with EPA's wheelbase criteria.

One metric that works very well to distinguish "heavy-duty" light trucks is the full-float axle. Most suspension systems put the wheel bearings around the axle shaft (referred to as "semi-float"). Full-float axles put the wheel bearings around the axle housing. This is an expensive, heavy, and very effective way to increase the load capacity of the vehicle. It is the traditional distinction between ½ ton and ¾ ton trucks.

Relative safety impacts of weight and size

The NAS Committee seems to have opted for weight rather than size adjustments because of its belief that – due to safety considerations – it is important to eliminate influences toward small cars. As discussed previously, Honda concurs with the dissenting opinion expressed by committee members David Greene and Maryann Keller that the data is insufficient to conclude that safety is compromised by smaller cars. The level of uncertainty about fuel economy related safety issues is much higher than stated in the majority report. Significantly, existing studies do not address the safety impact of using lightweight materials without reducing size, especially for vehicles with advanced safety technology.

We believe it is important to understand the differences between size and weight. We have demonstrated through the use of sophisticated engineering and advanced lightweight materials that smaller cars can be made increasingly safer.

Vehicle design and size, not just vehicle mass, must be considered when studying the relationship between fuel economy and safety. To what extent can new, lightweight materials and sophisticated engineering provide a level of crash protection comparable or even superior to vehicles with traditional materials and designs? Honda supports the NAS recommendation that NHTSA undertake additional research to clarify the relationship of weight and size in the context of newly evolving advanced materials and engineering techniques in the array of accident scenarios that are encountered on American roads.

11. *Again taking note of the NAS report, please comment on the possibility of tradable fuel economy credits and the potential cost and benefits to each manufacturer.*

There is no downside to tradable fuel economy credits. Trades will only occur if both sides believe that they benefit. Thus, there is no "cost" to any manufacturer. Honda supports the inclusion of tradable fuel economy credits in any CAFE program.

However, if trading is permitted only between vehicle manufacturers, there is not likely to be a lot of trading. Trading programs work best when there is competition amongst both buyers and sellers. As a handful of manufacturers control most of market, there would be virtually no competitive bidding or pricing. This also means a very inelastic supply of credits. No manufacturer can take the risk of waiting until the last minute to buy credits, because if they need more credits than are available, the price would skyrocket. Thus, trades would have to be arranged years in advance. Credit trading would work much better if manufacturers were allowed to trade with companies in other sectors of the market.

12. *Again taking note of the NAS report, please comment on the effect that elimination of the two-fleet rule would have on manufacturers, consumers, employment, the U.S. marketplace, and the auto industry in general.*

The NAS recommends abolition of the import/domestic split, or two fleet rule. Honda agrees with this recommendation. Regardless of what the original purpose of the rule may have been, circumstances in the auto industry have markedly changed since the original statute was enacted more than 25 years ago. Significantly, a number of international manufacturers have begun production in the United States. Honda, for example, now assembles more than 75% of its vehicles for the U.S. market in North America. We recently dedicated a completely new engine and motor vehicle manufacturing facility in Lincoln, Alabama where we will produce the Honda Odyssey – it is our 8th major plant in America. Depending on the formula used - and there are many - these vehicles contain between 70 and 90 percent domestic content. Over 90% of the steel used in these vehicles is domestic. Equally important, over 21,000 Americans are employed directly by Honda to design, develop, assemble, and sell these vehicles. Our dealer network employs an additional 78,000 Americans. In addition, Honda annual purchases over nine billion dollars worth of parts and components from about 450 U.S. suppliers, which are used in vehicles shipped worldwide.

The NAS believes the two fleet rule may act as a disincentive for manufacturers to increase the domestic content of their U.S.- built vehicles. Depending upon a manufacturer's global production plan, their more efficient vehicles may be made in the U.S. and thus are needed to be averaged with import vehicles to meet their CAFE obligations. Further, under CAFE, Canadian vehicles are treated as domestic, and soon as a result of the North American Free Trade Agreement, Mexican vehicles will be counted as domestic as well. It has outlived whatever usefulness it may ever have had.

13. *Noting recent attention in Congress and the media, please provide suggestions for modifications of the vehicle classification to separate "work performing" vehicles from passenger carrying vehicles.*

Honda does not oppose treating work-performing vehicles separately, provided that only actual work vehicles qualify for the exemption. If vehicles that primarily transport passengers qualify, this may create an artificial advantage for some manufacturers.

SUVs and vans should NOT be able to qualify as work performing vehicles. These vehicles are generally used for the same purposes as cars and should not be eligible for special exemptions.

It may be acceptable to exempt large pickups, which are often used for work purposes. However, any exemption criteria should at least include both a minimum pickup bed width and a minimum pickup bed length. Smaller pickups, with narrower pickup beds, should not be able to qualify. 4-door pickups and SUVs with short pickup bed lengths should not be able to qualify. Convertible pickup beds should not be able to qualify.

14. *Please provide comments on the possibility of raising the maximum gross vehicle weight rating and on the effects that this would have on manufacturers, consumers, U.S. auto industry employment, and the auto industry in general.*

Honda does not make any vehicles above 8500 GVWR. Thus, we have no comments on raising the GVWR criteria.

15. *NHTSA requests comments on the above possible modifications to the CAFE program and other modifications, such as those in the NAS report. For such modifications, please identify: their positives and negatives; their estimated costs and benefits; their effect on manufacturers, suppliers, employees, and consumers; and the policy implications of each. Also, please specify how much lead-time would be needed to respond to each modification and provide that information in terms of product planning cycles.*

Flexible Fueled Vehicles

In a separate proceeding, NHTSA recently extended for four years the incentive available for the production of vehicles, known as flexible fuel vehicles, that can operate on certain alternative fuels as well as on regular petroleum fuels. The incentive allows a flexible fuel vehicle to have a fuel economy 1.74 times as high as its actual fuel economy, with a 1.2-mpg maximum total increase per manufacturer. Citing an Energy Information Administration study, the NAS reports that for 1999, there were 725,000 vehicles capable of using the alternative fuel (E85) but only 3.1 percent of them were using E85 at all. Moreover, total E85 consumption in 1999 was only 2 million gallons by these vehicles, or less than 1 percent of the fuel used. If this pattern persists through the four-year extension, Honda urges NHTSA to evaluate whether the incentive is the most effective means of promoting alternative fuels and enhanced fuel economy performance.

16. *Referring to the three technology paths identified in the NAS report, comments are requested on whether these three technology paths represent likely scenarios for technology bundling. If not, please comment on which technologies are likely to be bundled together, and please identify the specific vehicle types and vehicles/models that might include them. Also, please comment on the technologies already included on the vehicle types/models, the projected vehicle weight and the percent of total model sales anticipated for each model (e.g., CVT-45%, 5-speed automatic-40%, 5-speed manual-5%). Finally, please comment on the assumptions the NAS made in evaluating the three paths. Are there more plausible alternative assumptions?*

The three technology paths identified in the NAS Report do not represent likely scenarios for technology bundling. Path 1 was readily available technologies that are already in production on reasonable numbers of vehicles. Path 2 was technologies that are just beginning to be commercialized. Path 3 was unproven technologies that are still in development, but should be able to be commercialized in the future. It was simply a way to separate short from longer term technologies.

As discussed earlier, bundling of technologies is based upon different assumptions and on previous technologies already installed on a particular vehicle. Thus, there is no consistent technology bundle that can be generically applied. While the assumptions made by the NAS committee in evaluating the three paths are reasonable, as previously discussed other reasonable assumptions could certainly be made.

Honda cannot comment on technologies already included on other manufacturers' vehicles or on projected sales of other manufacturers' vehicles. A list of the technologies on Honda's light duty trucks where included in Table 1 in response to Question 2.

17. *Should hybrid and fuel cell vehicles have been included in the paths? If so, which ones and which specific vehicle types? What technologies would be included with these types of vehicles?*

The NAS Report did not include hybrids or fuel cells in their technology paths. They concluded that, within the timeframe of their study, the cost-effectiveness of hybrid technologies was significantly worse than that of conventional vehicle technology and that fuel cells would not be ready.

Honda believes that both hybrids and fuel cell vehicles have a lot of promise and we are seriously pursuing their development. However, as concluded by the NAS Committee, there are still development and cost issues to be solved and, on fuel cell vehicles, infrastructure issues to be addressed. Thus, hybrids and fuel cell vehicles are not likely to be sold in large volumes in the time frames considered by NHTSA..

<u>Hybrid gasoline-electric vehicles</u>

Hybrids have a number of positive features that are desired by customers. They use gasoline (or diesel fuel); thus there are no concerns about creating a new infrastructure to support fueling. The customer benefits from lower fuel costs, extended range, and fewer trips to the gas station. Hybrids have good synergy with other fuel economy technologies and even help reduce emissions. Equally important, there is little impact on how the vehicle operates. The vehicles drive and operate similar to conventional vehicles. As evidenced by hybrid announcements from a number of manufacturers that indicate hybrid systems are being considered across a very broad vehicle spectrum, there appears to be no inherent limitation on the use of hybrid systems, as long as packaging, weight, and cost issues can be managed. While there remain some packaging issues such as finding space for the motor, battery pack, and power electronics, as well as some additional weight, these issues are secondary compared to the cost issue.

Unfortunately, the incremental cost of hybrid systems is not insignificant. Initially, hybrids also have high development costs spread over relatively low sales. Manufacturers are understandably reluctant to discuss the cost of their hybrid systems, so it is difficult to determine a realistic cost. Still, it is clear that hybrids currently cost at least several thousand dollars more than the equivalent conventional gasoline vehicle, with the cost increasing proportionally for larger vehicles. In the future, these costs should come down as the market expands and the technologies evolve, but in the near term cost is an issue.

To put the cost issue into context, one must examine what customers might be willing to pay in exchange for the fuel savings, both in the US and overseas using several assumptions. The most critical is customer discounting of fuel savings. JD Power's released some information on March 6, 2001 about their research on interest in hybrid vehicles. One of their conclusions was, "Of those who would consider a hybrid vehicle, nearly one-third indicate they would still buy one even if the savings from reduced fuel costs during their ownership period would be less than the extra cost of purchasing the hybrid option." This is encouraging, in the sense that there are a portion of customers who are willing to pay extra for hybrids. However, if you turn this statement around, it means that, even of the customers who would consider a hybrid vehicle, two-thirds would NOT buy it if the extra cost of purchasing the hybrid were more than the fuel savings *just during their ownership period.* This is roughly equivalent to assuming that most customers only value the fuel savings for about the first 50,000 miles of driving. For lack of information, the same 50,000-mile assumption is used for overseas customers (who drive less per year but may value the fuel savings more).

Estimates were made for three different size vehicles, small cars, midsize cars, and large trucks. Note that the baseline mpg estimates for each class are adjusted for real world driving conditions and are about 15% lower than the corresponding CAFE values. Estimates must also be made for the fuel economy improvement from a hybrid system. A reasonable factor for just the hybrid system and corresponding engine size reduction is probably about 30-40% over EPA's combined cycles. Sensitivity cases of 20% (for very mild hybrids) and 80% (for hybrids combined with moderate engine and load improvements) are also shown.

The final factor is fuel cost. The table lists two cases: \$1.50/gallon (US) and \$4.00/gallon (Europe and Japan). The formula used to calculate the fuel savings is:

$$\left[\frac{\text{50,000 miles}}{\text{baseline mpg}} - \frac{\text{50,000 miles}}{\text{base mpg}*(1+\text{FE inc.})}\right] * \text{Fuel cost}$$

Customer Value of Hybrid Fuel Savings (savings for the first 50,000 miles)

		Small car	Midsize car	Large truck
Hybrid FE increase	Fuel cost	34 mpg baseline	23 mpg baseline	14 mpg baseline
+ 20%	$1.50/gal	$368	$543	$893
	$4.00/gal	$980	$1,449	$2,381
+ 40%	**$1.50/gal**	**$630**	**$932**	**$1,531**
	$4.00/gal	**$1,681**	**$2,484**	**$4,082**
+ 80%	$1.50/gal	$980	$1,449	$2,381
	$4.00/gal	$2,614	$3,865	$6,349

From a **societal** view, the fuel savings over the full life of the vehicle (which are about three times the values in the table), would likely justify the approximately $3000 cost of hybrid systems. However, the typical **customer** would not value the fuel savings enough to pay for the incremental cost of $3000, especially in the US. In Japan and Europe, there may be a substantial market for hybrids even at a cost of $3000, due to the higher fuel prices. If the hybrid cost could be reduced to $1500 or $2000, the majority of customers in Japan and Europe might be willing to purchase a hybrid vehicle. To address the cost differential in the American market, the costs would have to come down or the price of gasoline increase significantly.

Even in the US, there are customers who, because they drive a lot or value the benefits more highly, will be willing to pay a $3000 premium for a hybrid vehicle. However, it is clear that hybrids will not break into the mainstream market in the US unless the cost of hybrid systems comes down and/or some sort of market assistance or incentive program is adopted.

Over the next five to ten years, we are likely to see a gradual increase in hybrid sales in the US. While the approximately $3000 cost increment in 2003 is too high for the mass market in the US, enough customers will desire the features to keep the market growing. In addition, hybrid sales may increase much faster in Europe and Japan, due to their much higher fuel costs. This could lead to higher volume production and further development, both of which will reduce cost worldwide. Sales in the US will continue to increase as the costs come down.

But there is a broader message here for US policymakers. All of the technology improvements that can be made are incremental and have a financial cost. Absent marketplace signals as well, progress on achieving higher fuel efficiency in the marketplace may be slower than we may desire.

Fuel Cells

Fuel cells are the most promising mid- to long-term option. Hydrogen fuel cells have virtually no emissions and are extremely efficient. Large-scale production of hydrogen would probably use natural gas, which would reduce our dependence on fossil fuels. Even longer term, we may be able to produce hydrogen using solar energy or biomass fuels.

However, there are many issues to resolve before fuel cell vehicles become commercially viable. Cost and size must be drastically reduced and on-board hydrogen storage density must be significantly improved. Durability must also be proved. Even after all these problems are solved, there are still infrastructure and fueling system issues to resolve. Thus, fuel cells will be a long time in development.

There also are serious concerns about on-board reformers for creating hydrogen. Reformers are the hardware that converts fuel like natural gas or methane, to hydrogen. These reformers are expensive, take up valuable space in the vehicle, and are slow to warm up and respond to transient driving conditions. In addition, they reduce the efficiency of the vehicle, both because of the energy needed for the reforming process and because the resulting fuel stream is not pure hydrogen. The dilution of the fuel stream requires a larger fuel cell stack to maintain the same performance, increasing weight, size, and cost of the system. In fact, recent research has concluded that fuel cells with on-board reformers may not be more efficient than a good gasoline hybrid.[2]

Honda's current research efforts are focused on direct hydrogen fuel cell vehicles. These are not yet ready for the public, not ready for "numbers", and not ready to help fill requirements for zero emission vehicles. (Although Honda has announced that we will offer a fuel cell vehicle for sale next year, this will be very limited production.) But even if all of the technological and infrastructure obstacles can be overcome, we are still at least two decades away from serious commercial introduction. However Honda is serious about this technology because it holds promise for environmentally sound transportation.

18. *Do you believe that the NAS study over or under estimated the fuel economy benefits from specific technologies? If so, which ones and why? Please provide data that suggest a different benefit resulting from the application of these technologies.*

As previously discussed, there is a range of reasonable engineering assumptions and technology implementation order. Different assumptions and different orders in which technologies are introduced will yield different results for specific technologies. This does not mean that one set of data are necessarily any better or any worse than another, only that the assumptions are different.

Honda's support for the technology estimates in the NAS Report needs to be viewed in this context. Honda does NOT support each individual fuel consumption benefit and cost estimate in the NAS Report. However, the NAS assessments have been exhaustively reviewed and commented on. Overall, their assessments of technology packages do not significantly over or under estimate the fuel economy benefits.

19. *Do you agree with the figures derived in the NAS break-even analysis? If not, why? Please address specific areas of differences, explain your reason(s) why, and provide supporting data for your reasons and arguments.*

There is a range of reasonable assumptions about both cost and fuel economy benefits for individual technologies. NAS's break-even analysis did a credible job of balancing the conflicting inputs and assumptions. Thus, overall, the figures derived in the NAS break-even analysis are reasonable and in the ballpark.

20. *NHTSA seeks comments on the following benefit issues: Can you provide, in addition to the material in the NAS report, any methods and data that would be helpful in identifying, quantifying, and expressing in dollar units the potential benefits of alternative CAFE standards (including energy security, environmental, and other considerations)? Are there any ancillary studies that NHTSA or other federal agencies should commission to provide a stronger technical foundation for making benefit estimates in future CAFE rulemakings?*

---

[2] "On the Road in 2020", M. Weiss, J. Heywood, E. Drake, A. Schafer, and F. AuYeung, Massachusetts Institute of Technology, October 2000.

Identifying, quantifying, and expressing in dollar units the potential benefits of alternative CAFE standards (including energy security, environmental, and other considerations) is an extremely complex task. It includes all sectors in the US economy, not just transportation, and it has international ramifications as well. Honda does not have any methods or data that would be helpful in such a process.